CENSUS FOR THE SOUTH NAHANNI MOUNTAIN CARIBOU HERD, September 2001

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CENSUS FOR THE SOUTH NAHANNI MOUNTAIN CARIBOU HERD, September 2001

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ABSTRACT

The Nahanni herd of woodland caribou has a main wintering area largely within Nahanni National Park and a cross-border summer-fall range near the Tungsten mine in the southern Mackenzie Mountains. Studies by Parks Canada biologists had defined the herd's seasonal ranges from standard VHF radio-collars and fall composition surveys in the mid to late 1990's, but the herd's size had not been previously estimated. Relatively low fall calf:cow ratios and increased hunter access had led to concerns about the sustainability of the harvest from both sides of the territorial border. In late September 2001, we carried out a helicopter-based census-survey of this caribou herd, with joint funding from the NWT, Parks Canada and Yukon. We counted 781 caribou and estimated herd size as 940 –1140 caribou based on a sightability correction derived from radio-collared caribou. Some questions remain about how distinct this herd's distribution is as overlap with neighbouring herds occurs in winter. The calf:cow ratio was 10:100, well below recruitment needed to balance natural mortality. However the survey was during the rut when the radio-collared cows showed high fidelity to the mountain plateaux, which increases the repeatability of the census. Hunter harvests (outfitters, licensed residents, and First Nations) were estimated at 36-44 caribou/year, or 4-5 % of the herd annually. Yukon Management Guidelines for woodland caribou indicate a sustainable harvest as 1-3% of a herd's size annually, from a stable herd. Given this harvest rate and increased access from the upgrading in 2001 of the road to the Tungsten mine, NWT and Yukon wildlife managers should work together to continue monitoring this herd's demographics, and to manage the harvest within sustainable limits.

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INTRODUCTION

There is little known about the Northwest Territories (NWT) and Yukon herds of Northern Mountain caribou *Rangifer tarandus* despite subsistence harvesting, outfitting and mining activities on their seasonal ranges. In the Yukon, most mountain caribou herds have been inventoried during the past 20 years, except in the southeast Yukon corner of the southern Mackenzie Mountains (Farnell et al. 1998). Possibly four herds seasonally use those southern mountains in the NWT and Yukon and these herds include the South Nahanni Mountain herd. Much of Yukon and interior Alaska has predator-suppressed woodland caribou and moose populations at relatively low densities, and experience has shown that they cannot tolerate heavy hunter harvests. The size, population trend and harvest of road-accessible caribou need to be monitored closely to prevent over-harvest and population declines.

First Nations people have a long history of using the South Nahanni Herd and a strong interest in the health of the herd. Obtaining a measure of herd size is part of evaluating herd health. Mining activity on the herd's calving and rutting grounds is increasing (North American Tungsten Corporation re-opened the CanTung Mine at Tungsten, mining exploration is being renewed at Mac Creek and Howards Pass sites). The Nahanni Range Road was upgraded in 2001 for all-season access; previously a washed-out creek had restricted fall hunter traffic on the nothern portions of the road. Improved access may lead to increased hunting and has the potential to cause additional stresses to the caribou herd, including habitat loss and/or degradation.

The South Nahanni caribou herd ranges over an area of 18,000 km^2 in the Selwyn-Logan-Mackenzie Mountains, which includes the western half of Nahanni National Park Reserve (Gullickson & Manseau 2000). The herd winters primarily within the Nahanni National Park Reserve, and Parks Canada, in co-operation

with Liidli Kue First Nation, started baseline research in 1995 and carried out the study for 3 years (Gullickson & Manseau 2000). The study used radio-collared cows to describe seasonal ranges and to locate the herd to facilitate sex and age composition counts.

Given the potential for increased access and hunting on the herd's calving, summer and rut ranges in association with mining activity, Parks Canada, the NWT's Department of Resources, Wildlife and Economic Development (RWED) and Yukon Department of Renewable Resources (YRR) agreed in January 1998 to continue collecting information on the South Nahanni caribou herd (Gunn *et al.* 2000). In October 1998 and March 1999, YRR and RWED fitted 22 new VHF collars and six satellite collars to monitor movements and overlap with neighbouring herds on the winter ranges. The objectives included obtaining a baseline estimate of herd size. Baseline information on herd size will also be useful to the mining industry and environmental assessment agencies. The need for an estimate increased following results from fall composition counts in 1995-2000. Between 1995 and 2000, we documented 4 years of low calf survival with an average of 20 calves:100 cows. Calf:cow ratios below 20:100 are considered as recruitment inadequate to replace natural mortalities of caribou (Yukon Renewable Resources 1996).

This report describes the results of determining the size of the South Nahanni caribou herd and obtaining calf:cow and bull:cow ratios in late September 2001. In the Yukon, herd size is determined through total counts (Farnell and Gauthier 1988) and stratified random block sample methods (Farnell and Gauthier 1988) are used to estimate caribou abundance either during late winter or the rut. We undertook a rut count because previous information (Gullickson & Manseau 2000) and subsequent satellite-collaring (Gunn *et al.* 2000) suggests that three, possibly four herds, winter on adjacent or overlapping winter ranges within and south of Nahanni National Park Reserve. Fidelity of radio-collared caribou to

distinct summer-fall alpine blocks in the Tungsten area is high, however, which justified a rut count.

METHODS

The survey area was determined from the October distribution from 1995-1997 and 2000 conventional radio-collar relocation data (Figures 1-4). We used natural terrain boundaries on topographical maps to divide the survey area into relatively uniformly sized survey blocks. All survey units were surveyed with approximately 100% coverage along the treeline, plateau tops and valleys, using two helicopters over a 3-day period. All caribou seen were classified by sex and age to obtain the ratio of calves to cows and bulls to cows. Additionally, active radio-collared caribou were located by a fixed-wing aircraft to test accuracy by comparing the number of collared caribou located to those not observed during the intensive search. This correction factor will provide an extrapolated population size estimate with minimum sightability bias. A radio-tracking flight the day after the intensive search survey identified whether caribou moved between survey units during the count.

RESULTS

We searched for caribou in 39 blocks (Figure 5) and counted a total of 781 caribou in 24 blocks on 25, 27 and 28 September 2001 (Appendix A). The blocks were in two groups: blocks 1-26 were northwest of Tungsten (Selwyn Mountains and the northern edge of the Ragged Range) and blocks 27-39 were southeast of Tunsten (southern part of the Ragged Range and Mount Hamilton Gault) and overlapped the northwest end of Nahanni National Park Reserve. Most caribou (92%) were in the northwest set of blocks where 59% (457/781) of the caribou were in only 4 blocks (15%, 4/26) (Figure 5, Appendix A). Those 4 blocks were the alpine and subalpine plateaus clustered around the Little Nahanni River and

also draining into the Upper Hyland and Little Hyland rivers, Lened Creek, Steel Creek, Mac Creek and Zenchuk Creek. We flew 22 hours searching and counting and we averaged 36 min ± 3 min (Standard Error) search time per block. Search time included the time for counting and classifying caribou.

On 25 September and 28 September 2001, the weather was high scattered to broken cloud, with excellent visibility. On 27 September, conditions were variable with low cloud and snow squalls on the eastern survey blocks in the morning, but the weather improved in the afternoon with broken cloud and patchy sunlight making fresh tracks conspicuous. More snow fell on 26 September and the snowline was at approximately 2000 m above sea level (asl). We observed most caribou about the snowline where there were dwarf birch shrubs but we saw some groups on snow-covered plateaus and a few groups in smaller side-valleys with only scattered snow cover. Experience with similar mountain herds in the Yukon indicates that very few caribou are likely to be below treeline at this time of year.

We located 11 radio-collars of the possible 18 collars (Figure 6, Appendix B) and heard a further three with mortality signals and two with only faint signals (we could not able to establish an exact location). Two collars (070 and 470) were not heard but these were the same two collars we were unable to hear in October 2000. We radio-tracked on 25, 27, 29 and 30 September 2001, 1 and 2 October for a total of 21.5 hours. The area covered (Figure 6) exceeded the area identified from the 1995-97 radio-tracking efforts and included a single flight to the satellite-collar locations for the Coal River and La Biche caribou. We also covered the eastern ranges of the Finlayson herd (Little Owls Mountain, Mount Pike north to Mount Wilson).

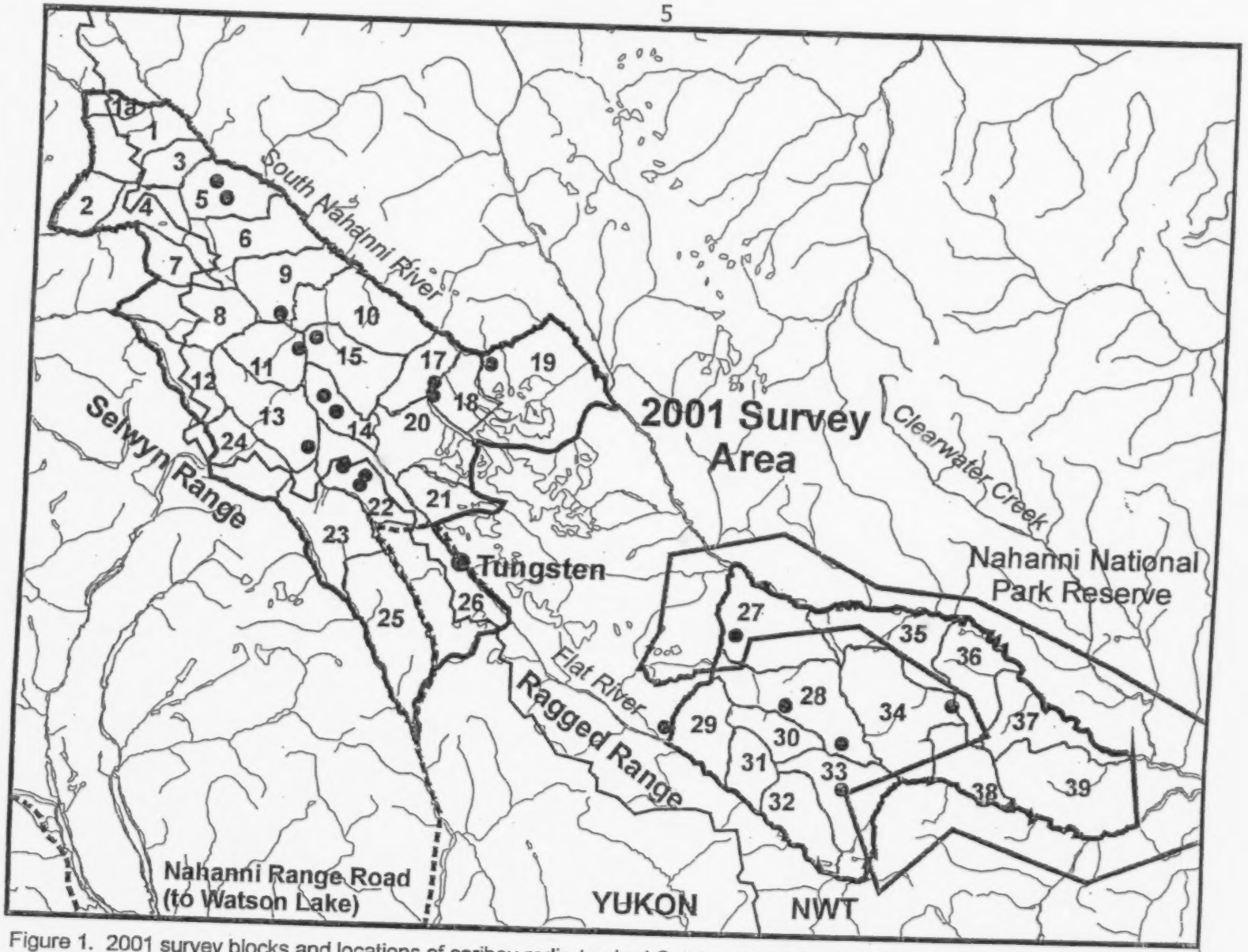


Figure 1. 2001 survey blocks and locations of caribou radio-tracked October 1995, South Nahanni Mountain caribou herd, NWT and Yukon (from Gullickson and Manseau 2000).

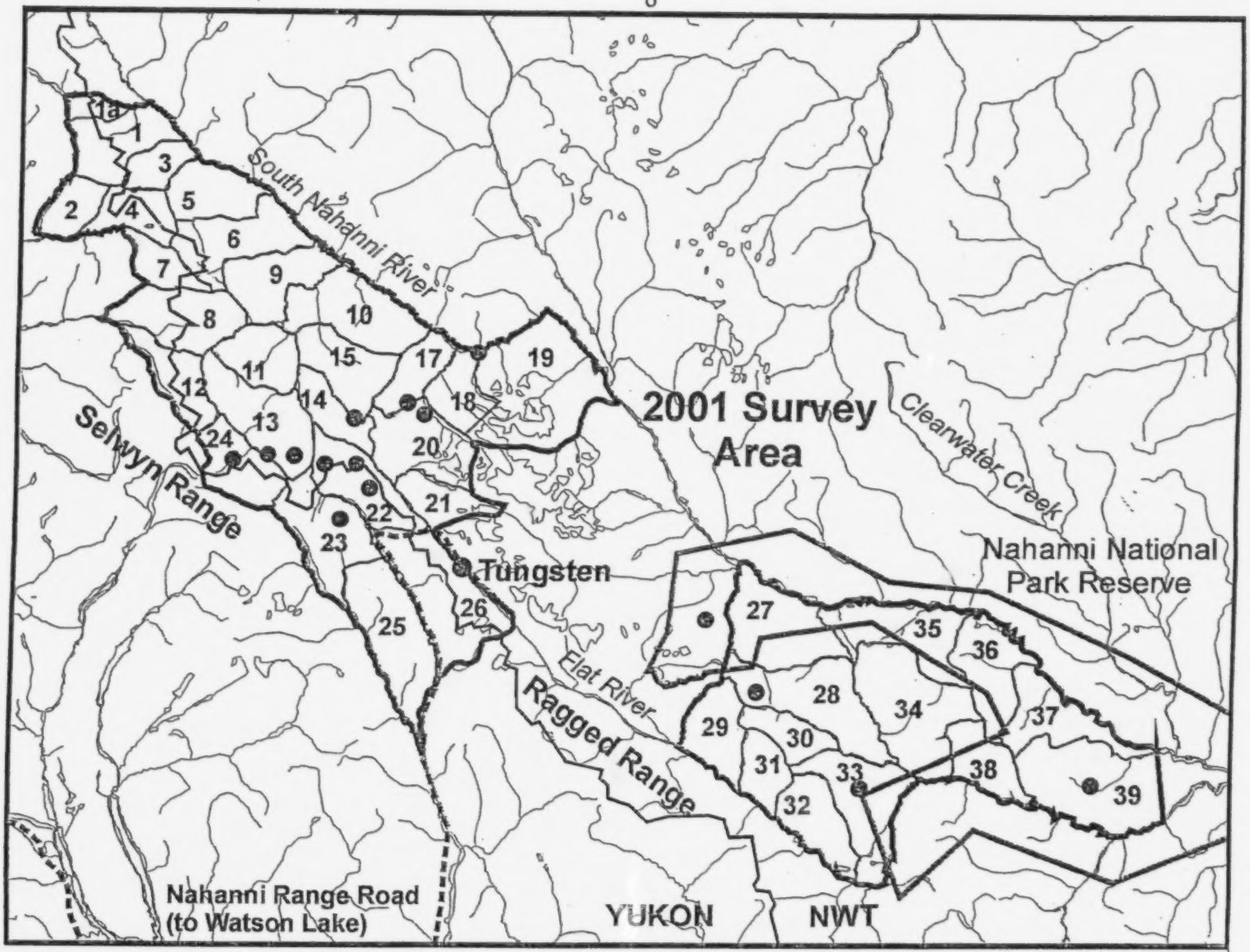
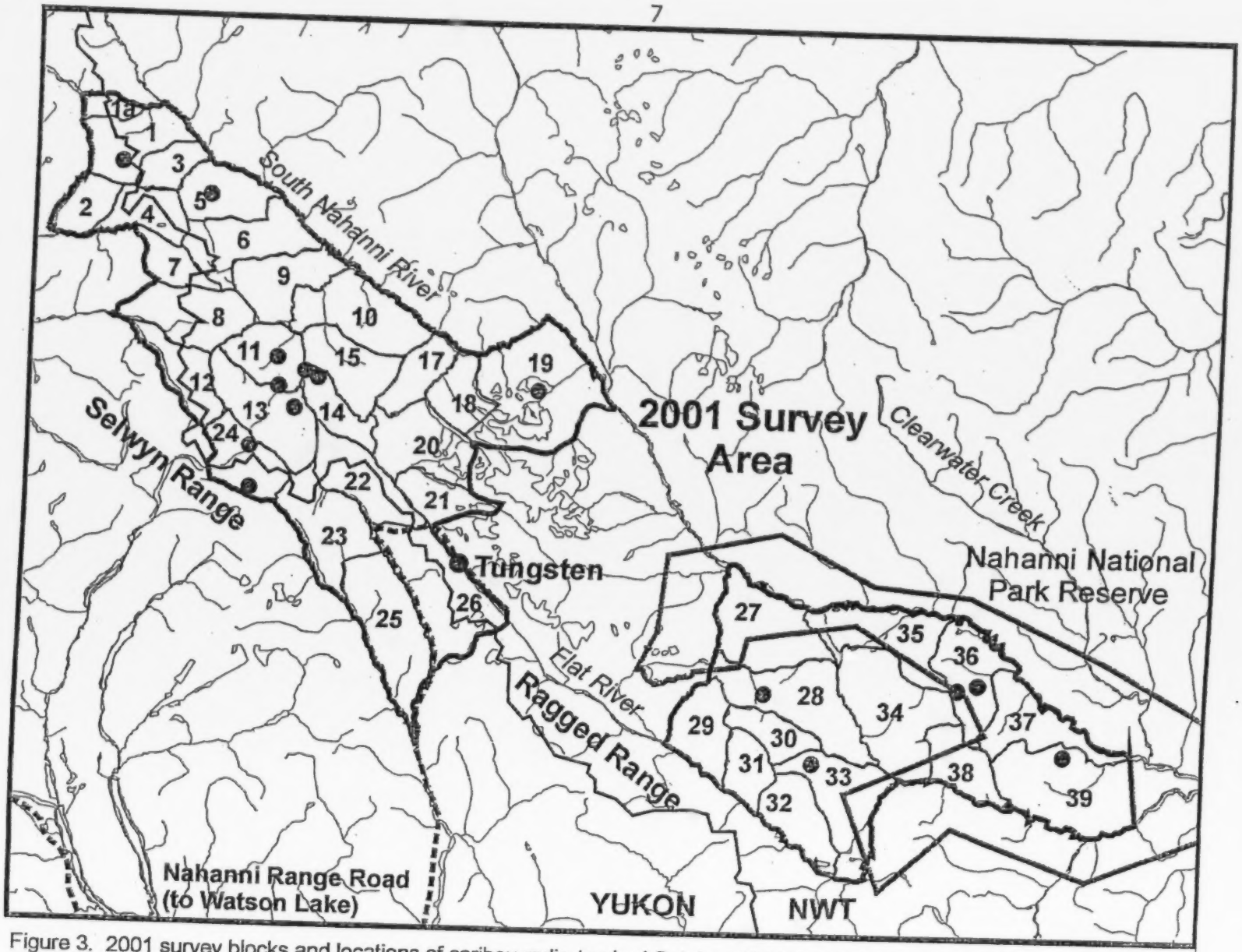


Figure 2. 2001 survey blocks and locations of caribou radio-tracked October 1996, South Nahanni Mountain caribou herd, NWT and Yukon (from Gullickson and Manseau 2000).



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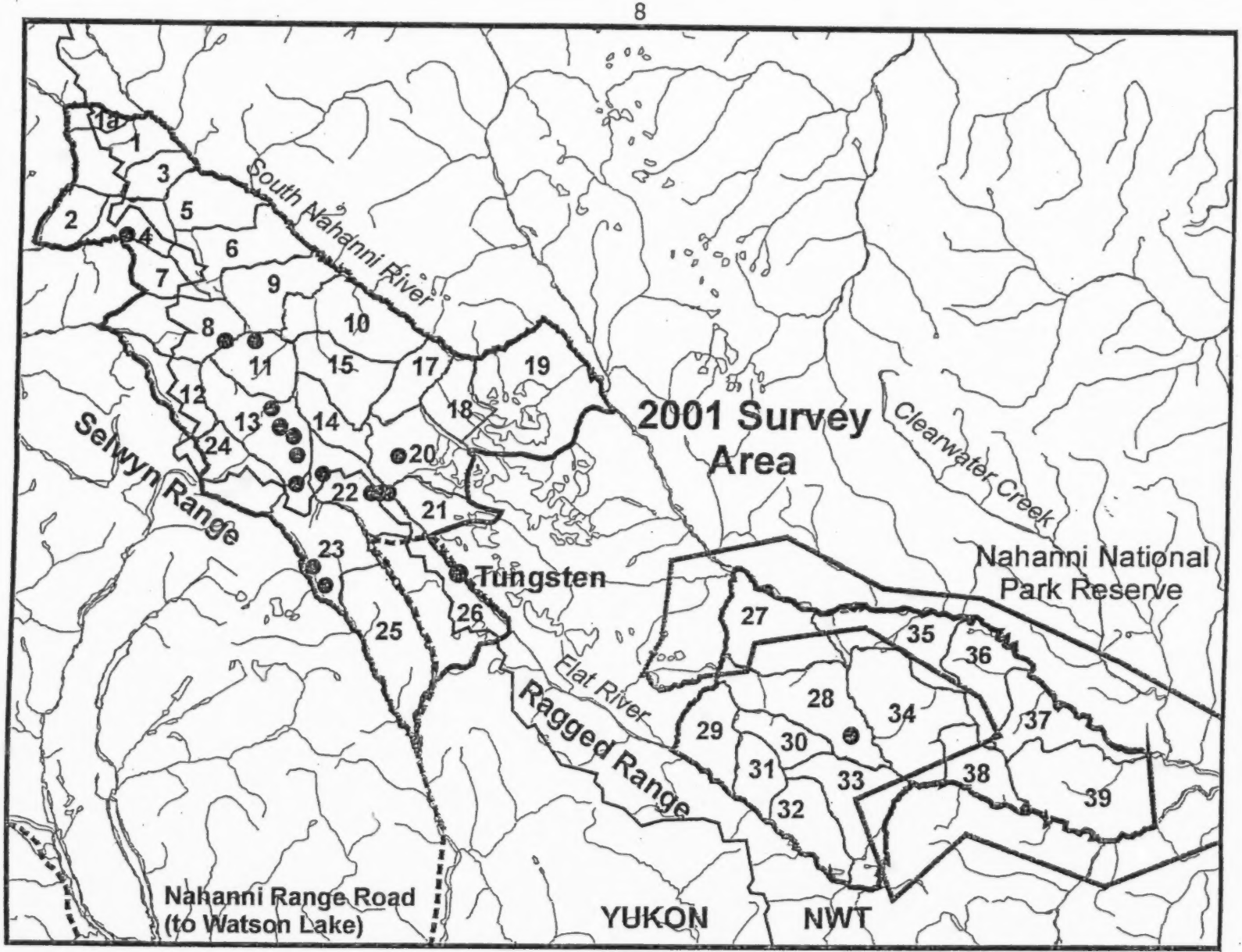

Figure 4. 2001 survey blocks and locations of caribou radio-tracked October 2000, South Nahanni Mountain caribou herd NWT and Yukon (from Gunn et al. in prep).

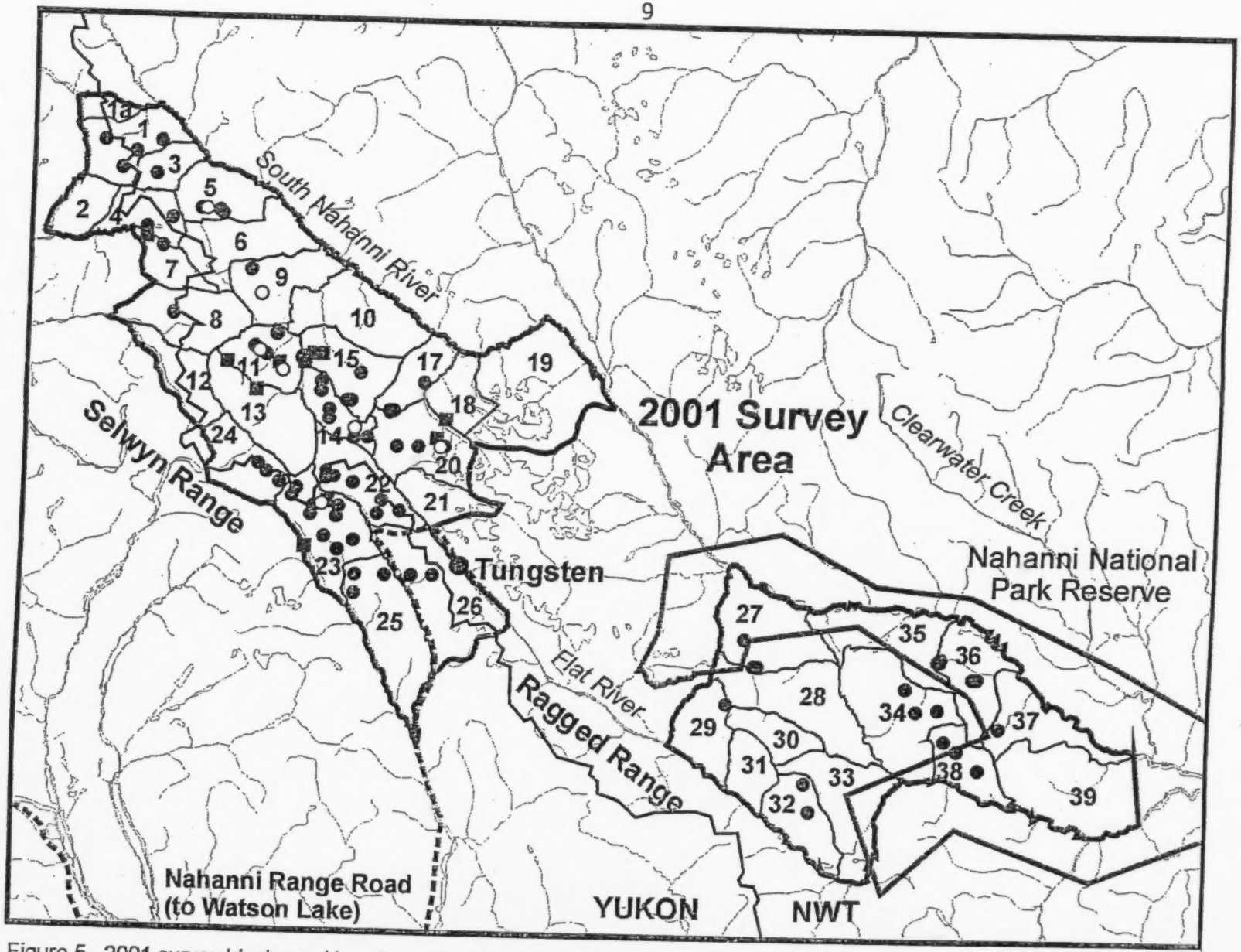

Figure 5. 2001 survey blocks and locations of caribou radio-tracked September 2001 (■) and caribou groups counted and classified (●, if a collar was present in group ○), South Nahanni Mountain caribou herd, NWT and Yukon.

The radio-tracking revealed that all 11 collared caribou (excluding the three mortality signals and the two faint signals) were within the north west set of survey blocks (Figure 6). During the visual searches to count the caribou, we saw 7 radio-collared caribou cows on the 27th and 28th September and we returned to those locations on the 29th to identify their frequency (Table 1). Snow squalls and low cloud hampered the tracking and we only visually located the collared cows and identified their frequencies in blocks 11 (within 2 km of the previous day's observation of the collared cow) and 20 (same co-ordinates as the previous day). In blocks 14 and 23, we identified the radio-collar frequencies for the collared cows seen the previous day and their locations were 5 and 10 km from where the group had been seen the previous day. Cow 410 in Block 23 had returned to the location where she had been radio-tracked at on 27 September. We did not re-check two of the collar sightings – one in block 5 and one in block 11. The cow with an orange collar seen in block 5 was most likely collar 510 radio-tracked in block 4. She had moved 13 km between 27 and 28 September.

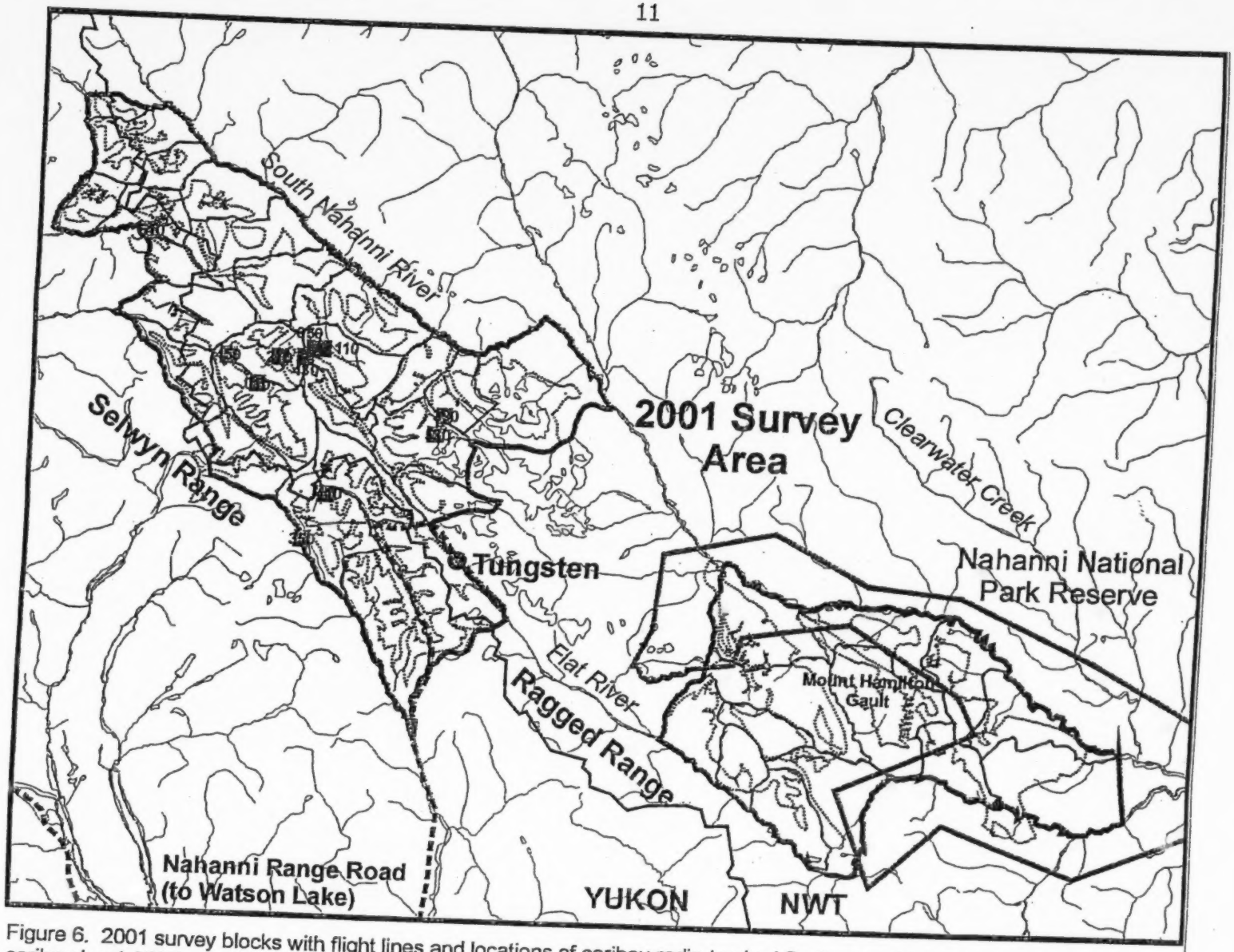

Figure 6. 2001 survey blocks with flight lines and locations of caribou radio-tracked September 2001, South Nahanni Mountain caribou herd, NWT and Yukon.

Table 1. Sightings of collared caribou and their likely identity based on subsequent radio-tracking, September 2001, South Nahanni area, NWT and Yukon

Block No.	Colour of collar seen (Date seen)	Radio-collar located 29 Sept	Comment
5	Orange (Sept 28)	-	Probably 510 – not checked
9	Green/yellow (Sept 28)	050	Signal heard but not located
11	White (Sept 27)	-	Not checked
11	Green (Sept 27)	450	Within 2 km of group's located 27th
14	Tan (Sept 28)	432	Within 10 km of group's location 28th
20	White (Sept 27)	530	Same co-ordinates as group located 27th
23	White (Sept 27)	412	Within 5 km of group's location 27th

During the counting, we classified caribou into sex and age classes and recorded 504 cows, 50 calves, 91 immature bulls and 113 mature bulls (Appendix A). The calf cow and bull:cow ratios were 10 calves:100 cows and 40 bulls:100 cows (Table 2). Mean group size for 83 groups was 9.4 ± 1.3 (Standard Error, range 1-63). Most (90%) of the mature bulls were in groups although we did record 10 solitary mature bulls as well as 4 solitary immature bulls. Only eight groups did not have a mature bull and instead had a single immature bull (group size 2-5). Single mature bulls were in mixed-sex and age groups averaging 8 ± 0.8 (2-22) in size. The three largest groups (63, 61 and 40) had 5, 8 and 8 mature bulls. Cows were all in groups with bulls except two cow-calf pairs and one solitary cow.

Table 2. Calf and bull to cow ratios and sample size for the South Nahanni caribou herd, NWT-Yukon, 1995-2001.

Date	No. Groups (caribou)	Calf:100 cows	Bulls:100 cows	Source
25–28 Sep 2001	83 (781)	10	40	This report
4–7 Oct 2000	32 (549)	15	33	Gunn *et al.* In Prep.
8 Oct 1997	53 (733)	26	32	Gullickson & Manseau 2000
9 Oct 1996	99 (739)	20	47	Gullickson & Manseau 2000
15-16 Oct 1995	78 (813)	17	37	Gullickson & Manseau 2000

DISCUSSION

The count of 781 caribou gives a minimum size for the South Nahanni caribou herd in September 2001. The usefulness of the information partially depends on how close the minimum count is to the actual size of the herd (accuracy) and how repeatable the count will be in the future (precision). First, questions of how accurate the count is depends on whether we missed seeing caribou and whether we accurately counted the caribou that we saw.

Accuracy of the count depends on other factors, including our ability to detect caribou and count all individuals in a group. Detection is likely influenced by group size – it is more difficult to see a solitary caribou or a small group or their tracks than a larger group. However, the observers were aware of this potential bias and fresh snow and broken cloud with sunshine increased our ability to see recent tracks and find caribou. Conversely, it can be hard to count all the caribou if they are in large groups. During the rut the caribou are dispersed in moderate size groups and we only encountered 3 groups of 40 or more caribou. Fatigue, inexperience and airsickness can all contribute the likelihood of missing caribou.

However, we had experienced observers, we took frequent breaks flew short days (5-7 hours including ferrying), and airsickness was not a problem.

In the Yukon, a correction factor of 1.25 is used to account for caribou missed during the census and this is based on use of radio-collared caribou. However, it is a correction factor for caribou in the trees and we have revised it to 1.2 for caribou on the open alpine. Adjusting our count of 781 caribou by the Yukon correction factor suggests a herd size of 937 caribou. However, if we assume that all 11 radio-collars were equally available to be seen during the September 2001 count, and we actually saw 6 of the 11, then we could argue that we should increase the minimum count by 46% (6/11) to 1140 caribou. However, we may miss seeing the collars on the caribou and thus over-estimate the number of caribou that we could have missed. With the exception of collar 350 on the boundary of the survey area, the other 10 collared cows were within 5 km of the census flightlines although at variable distances from the flightlines (Figure 6). Those caribou could possibly have been seen but the collars missed. Some of the collars were old and would have shown little contrast with the adjacent caribou hair.

Another potential source of error is if caribou moved between the survey blocks during the survey. Survey block boundaries had been selected to be valleys wherever possible to minimise the likelihood of movements confounding the counts (we assumed that during the rut caribou were unlikely to descend in elevation and cross a river valley to another mountain block). We flew the two sets of blocks within a 3-day period, which would have reduced the chances of movements (Figure 7). Interruptions by weather and initial difficulties in finding all the collared cows prevented our systematic location and relocation of radio-collared cows before and after the census to determine movements relative to

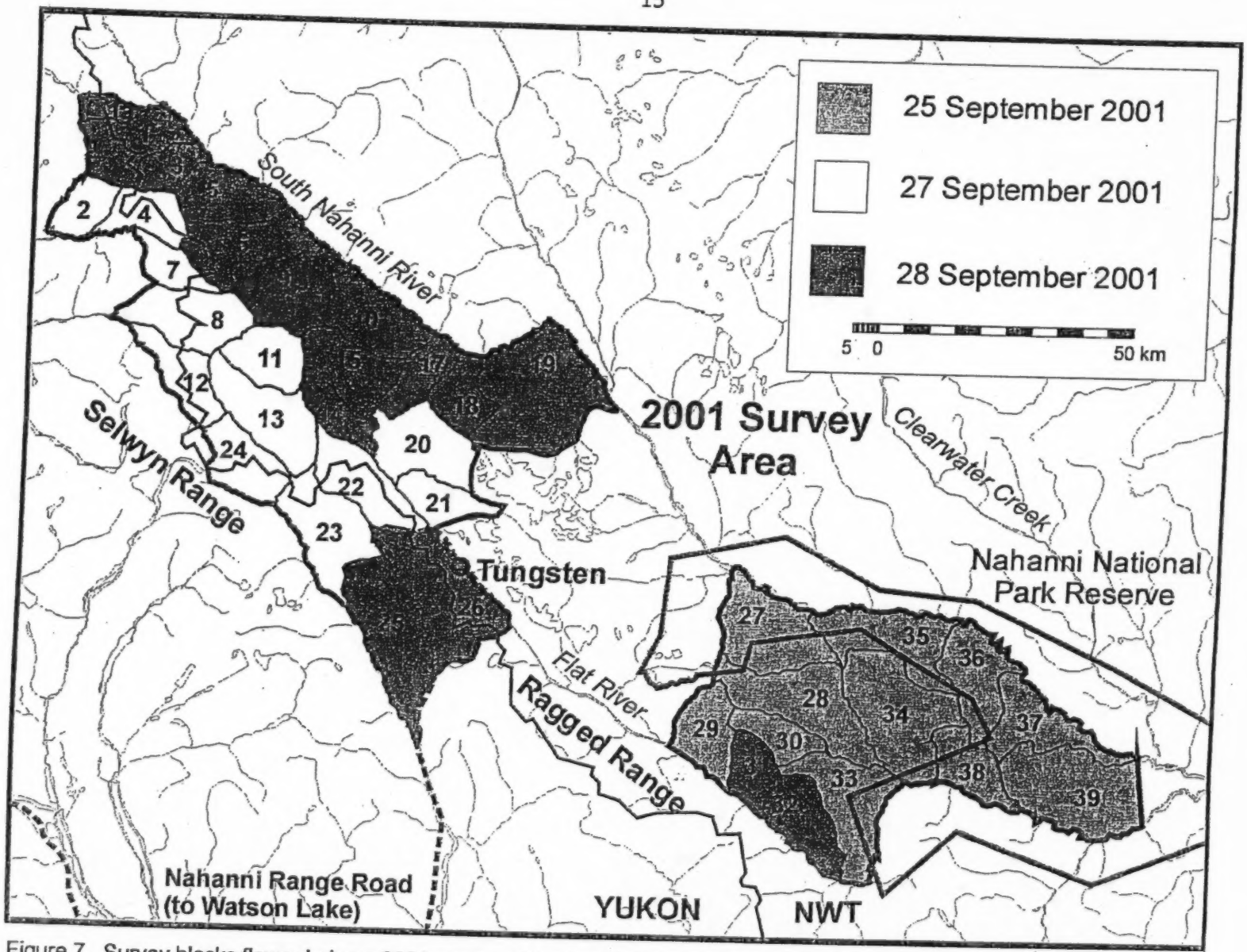

Figure 7. Survey blocks flown during a 2001 census of the South Nahanni Mountain caribo herd, 25-28 September, NWT and Yukon.

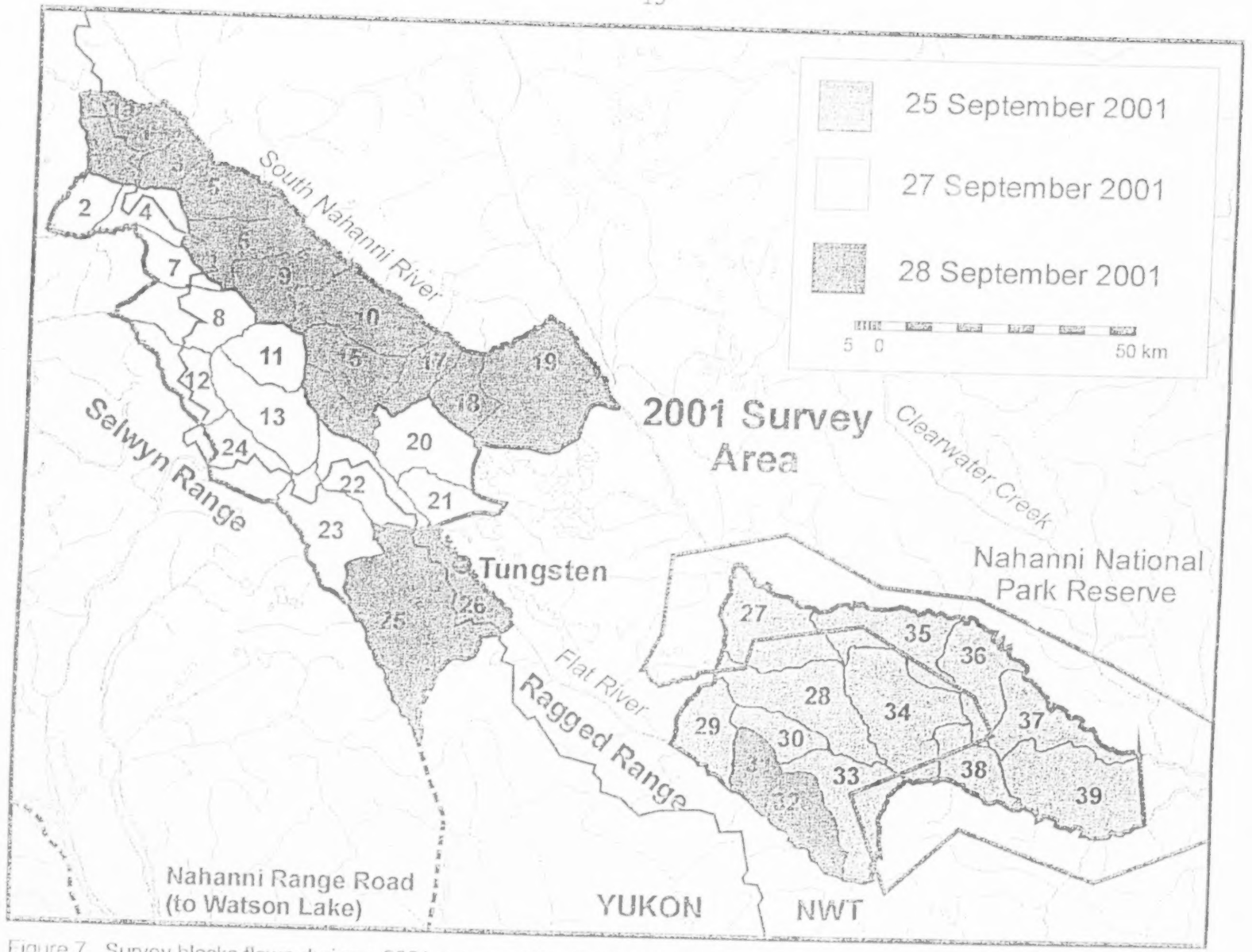

Figure 7. Survey blocks flown during a 2001 census of the South Nahanni Mountain caribo herd, 25-28 September, NWT and Yukon

block boundaries. Cow 412 was at the same location on 27 and 29 September but had moved 15 km since the 25 September. Cows 512 and 432 had moved 11 km and 14 km between 25 and 27 September 2001.

We also have to address the question of whether our survey area included all rutting areas for the South Nahanni herd. We had defined the survey area as the two mountain ranges with the October locations of 25 radio-tracked caribou 1995-1997 and 16 radio-tracked caribou in 2000. However, in each year 1995-97, 2000 and 2001, not all the radio-collared cows were located. This could be due to a radio-tracking failure, a collar failure or the cows having alternative rutting areas outside the survey area. Gullickson and Manseau (2000:Appendix C) did not locate 9 of 56 possible collared cow rut locations 1995-97 (6 individual cows). However, all 6 cows were subsequently relocated, which ruled out collar failure. Only one cow (YB20) did not have a rutting location as her signal was not heard in October 1995 or 1996 (she was dead by October 1997). Another cow (YB03) was located during 6 radio-tracking flights but not in October 1995 or during the subsequent 6 flights except once in June 1997, which might indicate a collar malfunction. Of the other three cows without an identified rutting location in 1996, all were located during the following rut in 1997.

In October 2000 and 2001, we did not hear signals from two collars (070 and 470), which were both cows that had been caught in the Selwyn Mountains in October 1998 (Figure 8). Both were radio-tracked on the winter range in March 1999. Cow 070's signal was detected in May 1999 in the Selwyn Mountains. The most likely explanation for the missed rut locations for cows 070 and 470 may then be radio-tracking failure rather than alternative rutting areas given the cows' relatively high fidelity to rutting areas.

The assertion that the cows exhibit fidelity is based on two assessments of the radio-tracking data. An initial assessment for fidelity is the straight-line distances

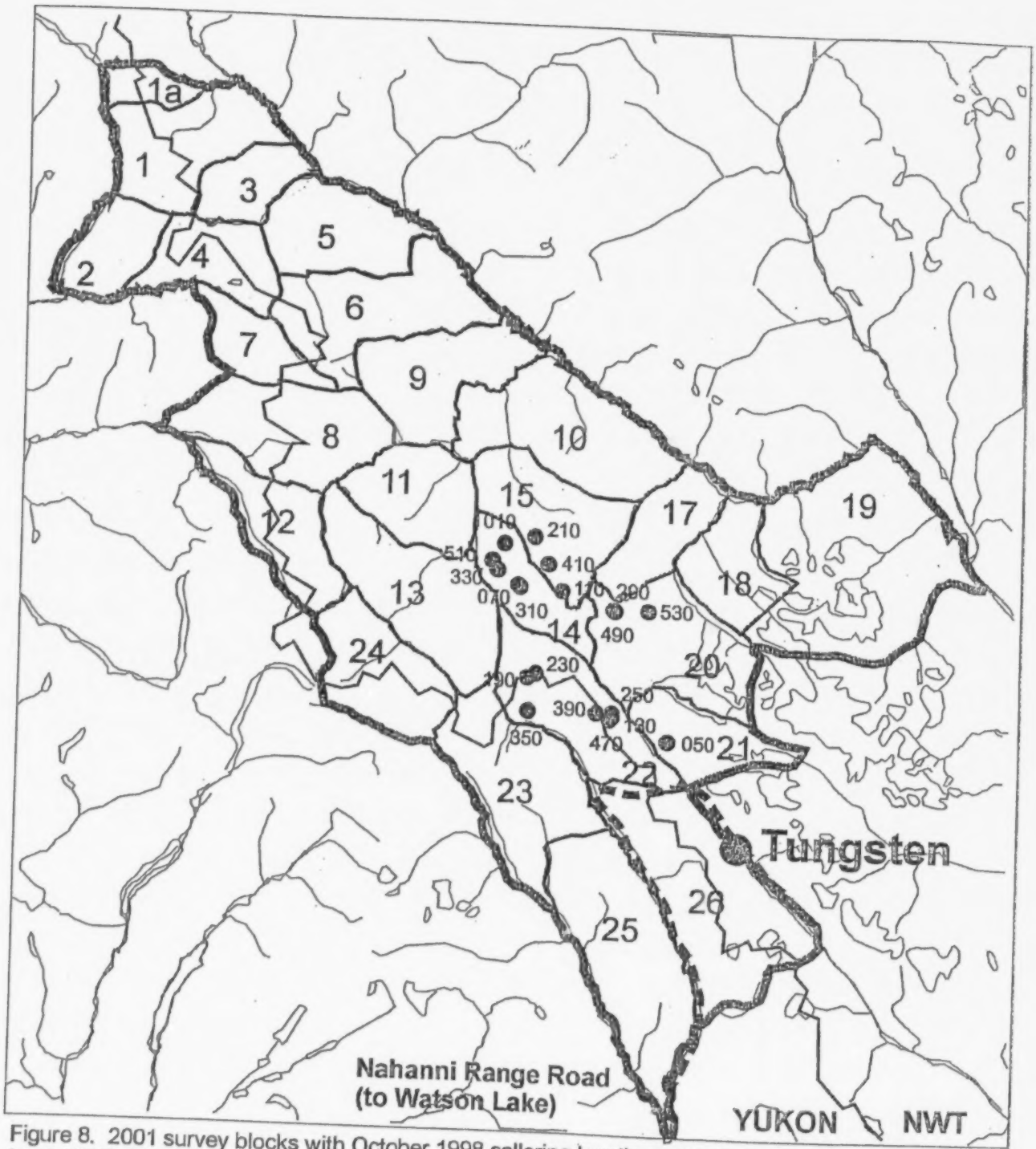

Figure 8. 2001 survey blocks with October 1998 collaring locations, South Nahanni Mountain caribou herd, NWT and Yukon.

between radio-tracked locations during October (the rut). From Gullickson and Manseau (2000), we determined that 9 cows had consecutive rut locations for 3 years and of those, 4 cows were located at sites within 10 km of each other and 5 cows within 40 km. We have no data for 1998 and 1999, but the 2000 and 2001 radio-tracking includes 5 of the original 1995 cows that were re-collared in 1998. Between 1995 and 2001, those cows rutted within a 2075 km^2 (Figure 9). However, the straight-line distances are only relative indicators of fidelity as they are based on locations that span a 3-week time period from late September to mid-October.

We can also assess fidelity at the landscape scale – whether individual cows had fidelity to particular mountain ranges. We know that caribou were rutting in the Lened area of the Selwyn Range in the 1980s (Envirocon Ltd. 1981). However, we have more specific information on fidelity to rutting areas from the radio-collar locations. The five cows with October locations from 1995-98, 2000 and 2001 remained within the Selwyn Mountain range (Figure 9). However, we can also use the larger sample size of 45 paired (consecutive years) locations to examine fidelity to mountain ranges from the 16 collared cows with two or more annual rut locations between 1995 and 1998 (Gullickson and Manseau 2000). Two of 16 cows switched October locations between the Selwyn Mountains and the southern part of the Ragged Range. Cow YB11 calved and rutted in 1995 and 1996 in the Selwyn Mountains but in 1997, she remained close to her wintering area in the South Nahanni River Valley within the National Park from calving to rutting. Cow YB16 migrated from her winter range to the Selwyn Mountains for summers 1995-97 (but at widely separated locations) and migrated between June and 12 October 1995 to the northern end of the Ragged Range. In October 1996, she migrated to the Selwyn Mountains after being north of the South Nahanni River in June and July. She also used the Selwyn Mountains in summer 1997 but was not located during the October 1997. Given the annual spread in the dates for radio-tracking from 1-12 October, we are likely to under-estimate fidelity as the cows

may already be starting migration to their winter ranges. For the cows radio-collared in 1998 and for those we have consecutive locations for in 1998, 2000 and 2001 none switched mountain blocks for the rut.

The fidelity for the rutting areas is a continuation of the fidelity to calving sites. For one year, only two cows rutted in a different mountain block than where they calved in contrast to the 43 paired calving and rutting locations for the 24 individual cows radio-tracked between 1995 and 1997. The 43 paired locations indicated the cows remained within the mountain block where they calved. The two exceptions were Cow YB03, which used the Dolf Mountains in June and July 1995, but moved to the Selwyn Mountains by October 1995 (48 km). Cow YB16 rutted in a different mountain block (Southern Ragged Range) than where she calved and spent the 1995 summer (Selwyn Range). Cows calving in the Selwyn-northern Ragged Range moved about twice as far to their October locations than the cows in the Southern Ragged Range (Table 3).

The repeatability of the survey will allow us to determine trends in herd size. Given that we used a standardised approach and recorded sampling effort (the exact search routes and time per block), the survey method is relatively repeatable. The caribou's fidelity to their rutting areas increases the likelihood of the survey's repeatability.

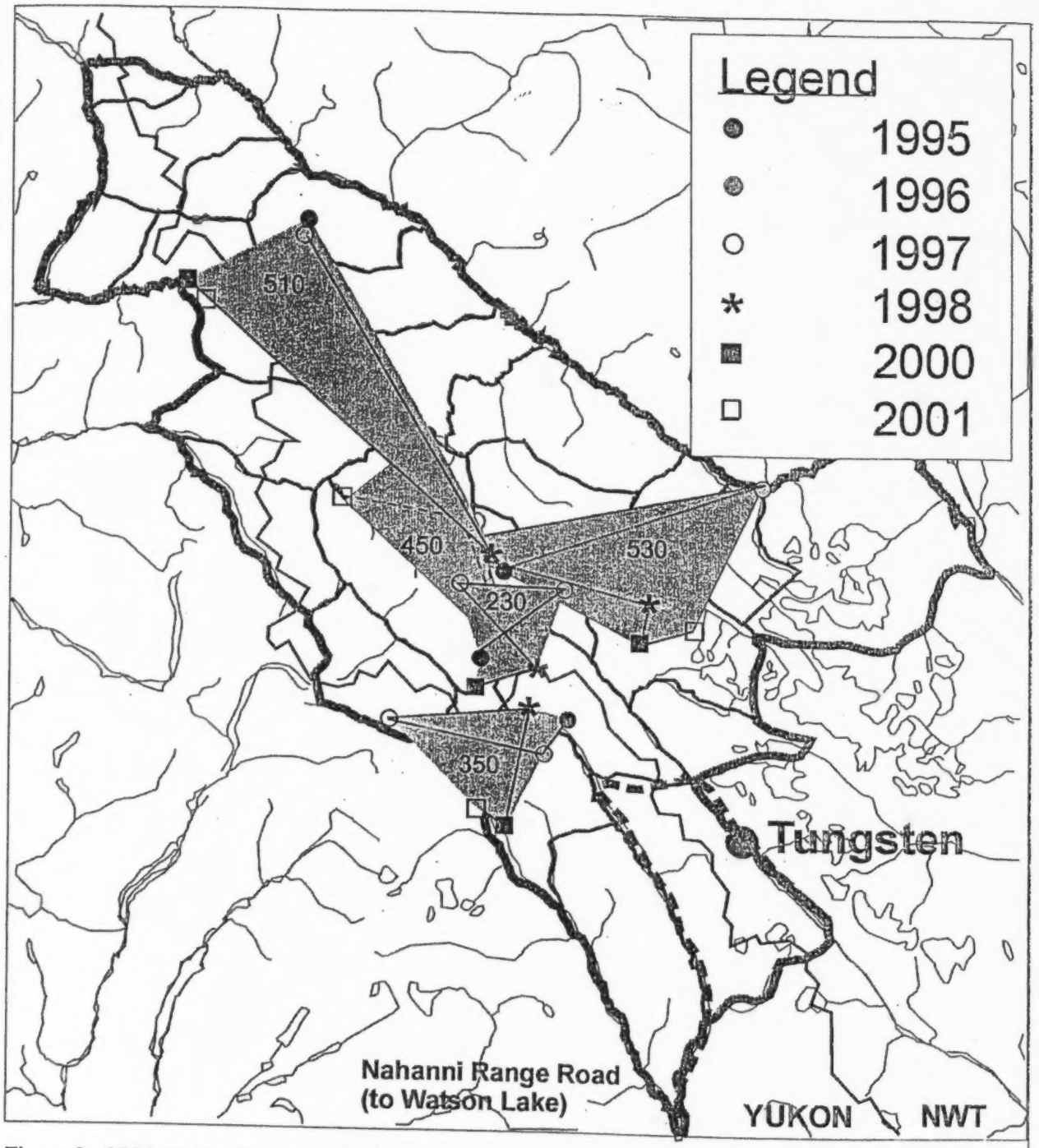

Figure 9. 2001 survey blocks and locations of five caribou radio-tracked October 1995 - 2000 and September 2001, South Nahanni Mountain caribou herd, NWT and Yukon.

We undertook a rut count because locations of the satellite-collared caribou and local information suggests we may have 3, possibly 4 herds, that winter on adjacent or overlapping winter ranges within and south of Nahanni National Park. The rut census carries with it the advantage that the caribou are more conspicuous, as they are still mostly on alpine and sub-alpine areas rather than in the trees. On the other hand, patchy snow can hinder their visibility and the weather can be poor during the fall.

Table 3. Distance in km between rut and calving radio collared caribou relocations split by northern and southern blocks of 2001 census

Collar id (1995-97)	1995 (1-4 Jun vs 12 Oct)		1996 (1 Jun vs 1-9 Oct)		1997 (3-6 Jun vs 6-8 Oct)		Comments Not consistent – put in missing data?
	North blocks	South blocks	North blocks	South Blocks	North blocks	South blocks	
YB01							
YB02	25.8		6.8		22.2		Dead Jul 95
YB03	47.6						
YB04		20.4					No Oct 96 or 97
YB05	40.1						Not pregnant 95
YB06	56.4		29.2				Dead Jun 96
YB07	13.4		18.2				Dead Oct 96
YB08	1.8						Dead Feb 97
YB09	40.7		44.7		11.2		No Jun/Jul 97
YB10	33.0				7.3		No Oct 96
YB11	42.9		17.7		26.5		
YB12	20.8		13.2			18.1	No Oct 96
YB13	33.2				11.4		Switch mt ranges
YB14	11.9		9.3	50.2	108.0		Not pregnant 95
YB15	29.7		10.6		24.4		Not pregnant 95
YB16		106.9	58.3				
YB17							Dead Jun 97
YB18							No Oct 97
							Not pregnant 95
							No Oct 95
							Dead Feb 96
							Dead Jun 95

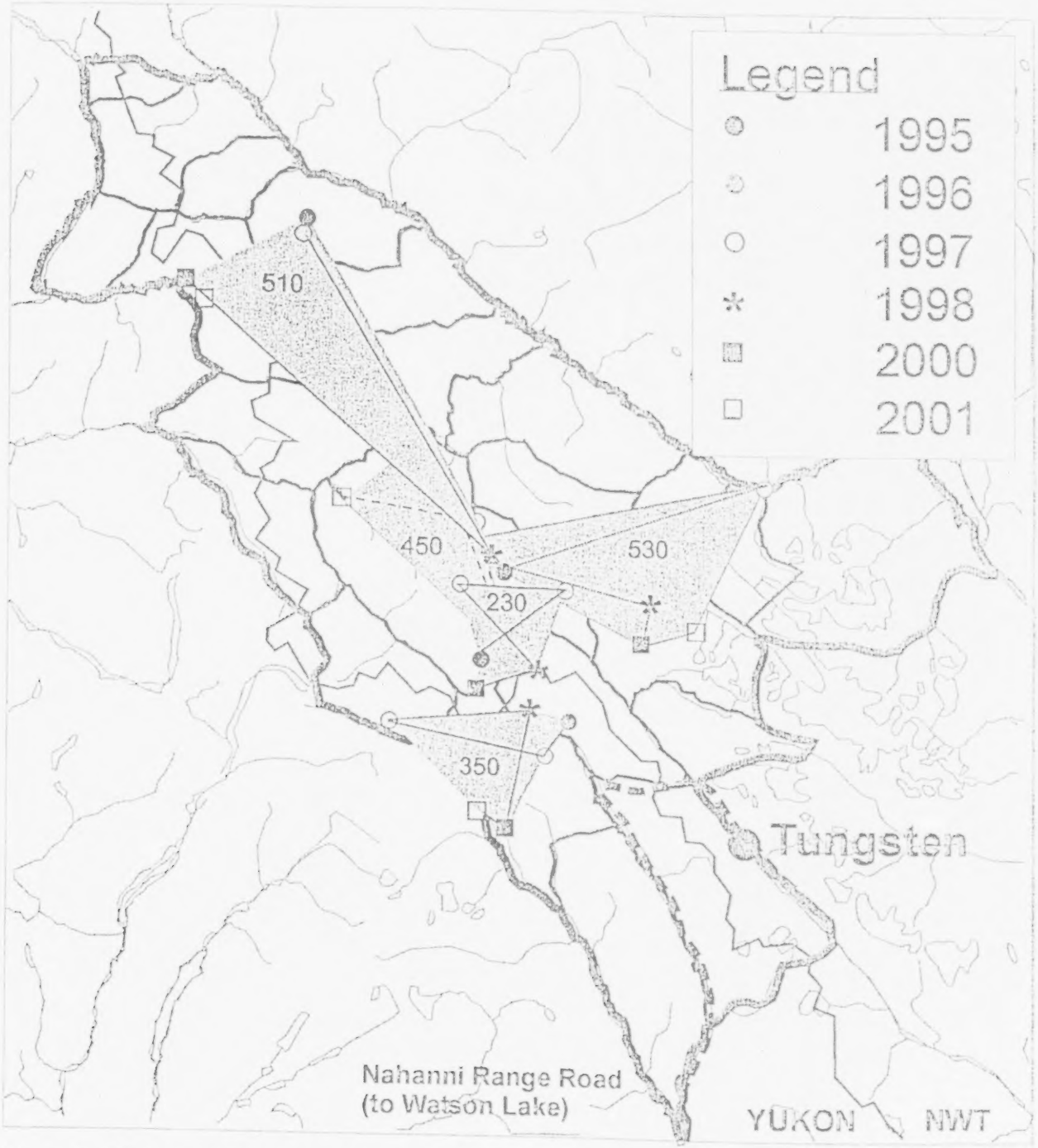

Figure 9. 2001 survey blocks and locations of five caribou radio-tracked October 1995 - 2000 and September 2001, South Nahanni Mountain caribou herd, NWT and Yukon.

We undertook a rut count because locations of the satellite-collared caribou and local information suggests we may have 3, possibly 4 herds, that winter on adjacent or overlapping winter ranges within and south of Nahanni National Park. The rut census carries with it the advantage that the caribou are more conspicuous, as they are still mostly on alpine and sub-alpine areas rather than in the trees. On the other hand, patchy snow can hinder their visibility and the weather can be poor during the fall.

Table 3. Distance in km between rut and calving radio collared caribou relocations split by northern and southern blocks of 2001 census

Collar id (1995-97)	1995 (1-4 Jun vs 12 Oct)		1996 (1 Jun vs 1-9 Oct)		1997 (3-6 Jun vs 6-8 Oct)		Comments Not consistent – put in missing data?
	North blocks	South blocks	North blocks	South Blocks	North blocks	South blocks	
YB01							
YB02	25.8		6.8		22.2		Dead Jul 95
YB03	47.6						
YB04		20.4					No Oct 96 or 97
							Not pregnant 95
YB05	40.1						Dead Jun 96
YB06	56.4		29.2				Dead Oct 96
YB07	13.4		18.2				Dead Feb 97
YB08	1.8						No Jun/Jul 97
YB09	40.7		44.7		11.2		No Oct 96
YB10	33.0				7.3		
					26.5		No Oct 96
YB11	42.9		17.7			18.1	Switch mt ranges
YB12	20.8		13.2		11.4		Not pregnant 95
YB13	33.2			50.2	108.0		Not pregnant 95
YB14	11.9		9.3		24.4		
YB15	29.7		10.6				Dead Jun 97
YB16		106.9	58.3				No Oct 97
YB17							Not pregnant 95 No Oct 95
YB18							Dead Feb 96
							Dead Jun 95

YB19		3.9		22.8		14.0	Not pregnant 95
YB20							No Oct 95, 96 Dead Oct 97
YB21		15.7		12.8		7.6	
YB22		11.2		2.6		11.6	
YB23							Not pregnant 95 Dead Oct 95
YB24	9.4				11.2		No Oct 96
YB25	45.7						No Jun 96, 97
Mean	**30.2**	**31.6**	**23.1**	**22.1**	**27.8**	**12.8**	
SE	**4.1**	**19.0**	**5.9**	**10.2**	**11.7**	**2.2**	

The herd's size has not been previously estimated. Gullickson and Manseau (2000) commented that R. Farnell (pers. comm.) had tentatively estimated the herd at 2000-3000 caribou but Gullickson and Manseau (2000) added that " . . . further insight into the South Nahanni and the adjacent Coal River Herd indicates that the herd size may be smaller". The 2001 census suggests that the herd is smaller but of particular concern, is the low recruitment and the potential for increasing harvest. Gullickson and Manseau (2000) noted the low recruitment between 1995 and 1997 (Table 2) and subsequently, recruitment as measured by fall calf:cow ratios has declined further. The harvest is poorly documented in the NWT as kill sites are not recorded for the guided hunting. The non-resident caribou harvest has increased (Gullickson and Manseau 2000) and further increases in resident hunting are likely as road improvements follow the increased mining activity. Further increases in the harvest are possible given restrictions of resident harvesting of the neighbouring Finlayson herd in the Yukon, which may displace harvesting to other herds. The annual harvest in the Yukon averages 16 caribou and in the NWT 16-24 (Gullickson and Manseau 2000), which suggests that conservatively, the harvest is already 4-5% of the minimum herd size (3.9-4.7% of our estimate of 937 caribou).

The low calf survival is likely directly or indirectly caused by deep winter snow and late spring snow melt. The effect is geographically spread throughout the

YB19		3.9		22.8		14.0	Not pregnant 95
YB20							No Oct 95, 96 Dead Oct 97
YB21		15.7		12.8		7.6	
YB22		11.2		2.6		11.6	
YB23							Not pregnant 95 Dead Oct 95
YB24	9.4				11.2		No Oct 96
YB25	45.7						No Jun 96, 97
Mean	**30.2**	**31.6**	**23.1**	**22.1**	**27.8**	**12.8**	
SE	**4.1**	**19.0**	**5.9**	**10.2**	**11.7**	**2.2**	

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The low calf survival is likely directly or indirectly caused by deep winter snow and late spring snow melt. The effect is geographically spread throughout the

Yukon mountain caribou herds as Yukon-wide average calf/cow ratios were low in 1999-2001 (15.8/100; n=13 herds in 2001). The years of low calf survival may be cyclic as Hik and Carey (2001) attribute decadal variation in annual horn growth in Dall's sheep *Ovis dalli* to climate variation. The relationship between horn growth and weather is mediated through both the affect of weather on forage growth and its availability in winter and relationships are complex (Hik and Carey 2001). Calf survival may return to higher levels if it is driven by a decadal pattern in climate. However, the decadal pattern may change with global climate change, which is predicted to be pronounced in the western Arctic.

The 5 years of low calf survival, our census results, the current harvest rate, and the likelihood that harvest rates will increase, lead us to raise the concern that the South Nahanni caribou herd is probably declining. Although we acknowledge a degree of uncertainty in that interpretation, we suggest that it is imprudent to wait for more certainty in our information and that management actions are necessary (Auster 2001). We recommend that the two territorial governments work with First Nations, Parks Canada, outfitters and the mining industry on preparing a management plan and monitoring program. In the meantime, we recommend that we continue to work with Parks Canada and Government of the Yukon on monitoring calf survival and overlapping use of winter ranges.

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Ken Davidge (Resources, Wildife and Economic Development) gave logistic help and with Edward Chollo (Fort Simpson) were keen observers during the census. Perry Linton (Northwright Air) provided his usual skilled flying for the radio-tracking and we also appreciated the flying of Colin Munro (Great Slave Helicopters) and Steve Soubliore (Capital Helicopters).

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Appendix A. South Nahanni Fall census/composition survey, 25-28 September 2001, South Nahanni caribou herd, NWT and Yukon

Unit no.	Obs no.	Ad Cow	Total calves	Imm Bull	Mat Bull	Uncl	Band Size	Lat_deg	Lat_min	Lat_sec	Lon_deg	Lon_min	Lat_sec	Search time
Date: 25 Sept 01														
27	1	1			1	1	3	61	49		127	6		
27	2			1			1	61	46		127	4		61
28														43
29	3	1			1		2	61	46		127	3		
29	4				1		1	61	46		127	3		
29	5				1		1	61	46		127	3		27
30														35
33														15
34	1				1		1	61	40	50.1	126	22	9.9	
34	2				1		1	61	43	16	126	29	19	
34	3				1		1	61	40	47	126	27	4	34
35														19
36	1			1			1	61	46	3.3	126	21	35.1	
36	2	2	1		1		4	61	46	23.9	126	21	19.4	
36	3	2		1			3	61	44	7.6	126	13	13.8	
36	4	2	1		1		4	61	44	7.1	126	14	8.5	31
37	1	1		1			2	61	38	40	126	8	24.3	15
38	1	1					1	61	34	16.8	126	13	6	
38	2	14	3	1	1		19	61	36	18.8	126	17	48.8	
38	3	1	1				2	61	37	28	126	20	47	17
39														9

Appendix A. Cont'd

Unit no.	Obs no.	Ad Cow	Total calves	Imm Bull	Mat Bull	Uncl	Band Size	Lat_deg	Lat_min	Lat_sec	Lon_deg	Lon_min	Lat_sec	Search time
Date: 27 Sept 01														
2														39
4	10	10		5	2		17	62	34		129	21		
4	11	4			1		5	62	33		129	27		
7	9			1			1	62	31		129	23		36
8	8	15	3	5	3		26	62	24		129	20		
11	1	8	1		2		11	62	20	11.8	128	59	29.2	
11	2	3	1	1			5	62	20	40.5	129	0	29.2	
11	3	1			1		2	62	22	3.7	128	55	28.4	
11	4				1		1	62	19	49.5	128	57	45.3	
11	5	5	3		1		9	62	18	9.8	128	53	59.4	28
12														34
13														37
20	1				1		1	62	10		128	27		
20	2	3			1	3	7	62	10		128	22		
20	3	9		1	1		11	62	10		128	17		
20	4	1	1	1			3	62	10		128	16		52
21														28
22	3					2	2	62	4	8.3	128	30	22.4	
22	4	17	2	3	2		24	62	6	1.1	128	37	7	
22	5	40	3	10	8		61	62	6	29.1	128	43	18.6	
22	6	12			1		13	62	7	12.1	128	43	7.1	
22	7	44	8	6	5		63	62	6	39.3	128	41.4	4.6	72
23	1	2		2	2		6	62	5	21.2	128	49	59.8	
23	2	28		4	8		40	62	4	29.5	128	51	2.8	
23	3	4		1	1		6	62	2	29.8	128	46	36.6	
23	4	9	1		2		12	62	3	25	128	46	3.7	
23	5	7	2	2	1		12	62	3	44.8	128	44	1.2	

Appendix A. Cont'd

Unit no.	Obs no.	Ad Cow	Total calves	Imm Bull	Mat Bull	Uncl	Band Size	Lat_deg	Lat_min	Lat_sec	Lon_deg	Lon_min	Lat_sec	Search time
23	6	9	1	1	1		12	62	2	18.1	128	40	36	
23	7	3	1		1		5	62	3	25.5	128	40	16.5	
23	8	18	1	2	1		22	61	59	46.3	128	36	41.3	
23	9				1		1	61	58	41.5	128	40	8.1	
23	10	9		1	1		11	62	0	8.2	128	43	26.6	73
24	5	2		1			3	62	6		128	54		
24	6	5	1		2		8	62	7		128	57		
24	7				1		1	62	8		128	59		55
Date: 28 Sept 01														
1	1	9			2		11	62	39	5.5	129	33	13.9	
1	2	4	2	3	2		11	62	42	5	129	37	30.2	
1	3	6	1		2		9	62	42	11.7	129	24	15.9	
1	4	13		1	3		17	62	40	56.5	129	30	11.8	53
3	1	9		1	2		12	62	38	38.3	129	25	9.9	18
5	1	2	1		1		4	62	34	57.6	129	9	55.6	
5	2	3	2	1	1		7	62	34	39.9	129	8	58.5	
5	3	19	3	2	3		27	62	35	10	129	12	58.4	
5	4	5		2	5		12	62	35	5	129	14	18.8	29
6														23
9	1	8	2	1	1		12	62	28	46.3	129	1	57.4	
9	2	2			1		3	62	26	17.1	128	59	23.3	26
10														40
14	2	7		1	1		9	62	13		128	43		
14	3	8		1	1		10	62	12		128	37		
14	4	5		1	1	1	8	62	11		128	34		
14	5	1		1			2	62	14		128	43		
14	6	24		7	3	4	38	62	16		128	45		
14	7				1		1	62	17		128	45		52

Appendix A. Cont'd

Unit no.	Obs no.	Ad Cow	Total calves	Imm Bull	Mat Bull	Uncl	Band Size	Lat_deg	Lat_min	Lat_sec	Lon_deg	Lon_min	Lat_sec	Search time
15	8	5			1	3	9	62	15		128	39		
15	9			1	1	1	3	62	15		128	39		
15	10	24		5	4	2	35	62	15		128	38		
15	11	9		3	1		13	62	20		128	45		
15	12	8			2	4	14	62	18		128	36		45
17	13	3		1	1		5	62	14		128	29		
17	14			1			1	62	14		128	28		
17	15	3		1			4	62	17		128	21		27
18														13
19														18
25	1	2		1			3	61	54		128	36		
25	2	5			1		6	61	56		128	36		
25	3				1	1	2	61	56		128	29		92
26	4				1		1	61	56		128	18		
26	5	1		1	1		3	61	56		128	23		72
29	1	3	1		2		6	61	42		127	10		27
31														12
32	1	3	1		1		5	61	30	11.3	126	51	20.1	
32	2	3	1		1		5	61	33	15.9	126	52	20.9	22
Totals		487	49	88	110	22	756							

Total number of adult cows: 504
Total number of calves: 50
Total number of immature bulls: 91
Total number of mature bulls: 113
Total number not classified: 23
Total number classified: 781

Appendix B. Locations of 1998 radio-collared caribou, 25-September to 1 October 2001, South Nahanni caribou herd, NWT and Yukon.

Collar VHF Frequency/Collar id 1995-97 (recollared)	Radio-tracking date (Sept 2001)	Location Lat / Long	Status
153.010	25/09	6216/12900	Active
153.050	30/09	6220/12847	Active
153.070			Unknown
153.110	25/09	6217/128/50	Active
153.130	24/09		Faint signal
153.210	25/09	6219/12855	Active
153.230	25/09	6208/12738	Mortality
153.250	25/09	6233/12858	Faint signal
153.310	25/09	6152/12601	Mortality
153.350	30/09	6159/12848	Active
153.370	1/10	6155/12737	Mortality
153.390	30/09	6213/12816	Active
153.410	25/09	6212/12840 (25)	Active
153.430	25/09	6915/12840 (25)	Active
153.450	25/09	6219/12907 (25)	Active
153.470			Unknown
153.510	25/09	6232/12927 (25)	Active
153.530	30/09	6211/12818	Active

Appendix C. A comparison of the distribution of radio-collared caribou cows (Oct 1995-1997, 2000) and groups classified by sex and age composition (Oct 2000 and Sep 2001).

Block No.	Composition 2001 (25-28 Sep)	Rut 1995 (12-16 Oct)	Rut 1996 (1-9 Oct)	Rut 1997 (7-8 Oct)	Rut 2000 (3-6 Oct)	Composition 2000 (4-7 Oct)
1a						
1	4 (48)			YB24		1 (36)
2	0 (0)	YB08, YB24				1 (5)
3	1 (12)				223/YB08	
4	2 (22)					3 (52)
5	4 (50)					
6	0 (0)					
7	1 (1)					
8	1 (26)			YB08	202	
9	2 (15)	YB12				2 (7)
10	0 (0)			YB10		
11	5 (28)	YB07			213	1 (22)
12	0 (0)					
13	0 (0)	YB02	YB07, YB15	YB09, YB02	200, 208, 217, 219, 209/YB02	1 (2)
14	7 (78)	YB09, YB14, YB10		YB12, YB07		4 (137)
15	5 (74)	YB06	YB02			4 (49)
17	3 (10)		YB06			
18	0 (0)	YB03, YB13	YB09			
19	0 (0)	YB11		YB13		
20	4 (22)		YB11		224/YB09	4 (55)
21	0 (0)					
22	7 (78)	YB15, YB25, YB05	YB12, YB14, YB16		204, 213, 216, 218	7 (139)
23	10 (127)		YB25		210, 215/YB25	
24	3 (12)		YB05	YB14, YB25		4 (45)
25	3 (11)					
26	2 (4)					
27	5 (8)	YB19				
28	0 (0)	YB16, YB04	YB19	YB19	205	
29	1 (6)					
30	0 (0)					
31	0 (0)					

Appendix C. Cont'd

32	2 (10)					
33	0 (0)	YB21	YB21	YB21		
34	3 (3)	YB22				
35	0 (0)					
36	4 (12)			YB11, YB22		
37	1 (2)					
38	3 (22)					
39	0 (0)					
Outside		YB23	YB20	YB20		
Total	**83 (781)**	**21**	YB13 **15**	**15**	**16**	**32 (549)**